Indus Journal of Management & Social Sciences
Vol. 1, No. 1: 70-82 (Spring 2007)

WASTE DISPOSAL AND STREAM FLOW QUANTITY AND QUALITY OF LYARI RIVER

Asif Mansoor * and Safia Mirza **

ABSTRACT

In this paper an attempt has been made to analyse the behaviour of Lyari River contaminated wastewater to main sea. Main focus is on the sate of water ways and physical, chemical and metallic parameters for effluents. Empirical analysis is done for the proper conclusion and implications. Lyari River is the natural stream having substantial catchments area. It has become a natural drainage channel for almost a quarter of the existing built up area of the city. Lyari River becomes a putrid and toxic channel when it passes through the metropolitan area of Karachi. It carries the water which is purely a combination of domestic sewage and industrial effluents. These effluents have very high load of pollutants and pathogenic bacteria. Where as the industrial wastes are the main source of toxic metal, pesticides and lubricating oils. These effluents contaminate the marine aquatic environment and coastal area. New models are given for analyses.

JEL. Classification: O21; O22; Q22; Q24; Q25; R14; R15

Keywords: Water-Disposal, Stream, Quantification, Parameters, Physical, Chemical, Metallic, Contaminate, marine-organism, bio-accumulation

1. INTRODUCTION

Lyari River is an ephemeral natural stream having substantial catchments area that starts from as back as Badra ranges 100 Km from the city of Karachi. Lyari River originates from the desert south of the Rab Ranges and enters the north end of the city at the Super Highway bridges at Sohrab Goth. From this location it flows in the south west direction towards Maripur road bridge, Once it was a dry river, carrying floodwater only for two or three days during rains. Now it carries waste waters and sewage through out the year. Its details are discussed in the report of Haq (1971).

Lyari River is one of the major floodwater-carrying river which passes through the main city area of Karachi. In the metropolitan area the flow length of the river appears to be 24.5 Km. Lyari plains are sandy and at places high embankments indicate the past heavy discharge of river. Its catchments are covering an area of 700 Km^2 out of which approximately 150 Km^2 lies in the metropolitan area. Lyari River accommodates approximately 0.8 million people in near about 50 Katchi abadies along both sides of its banks. As said

The material presented by the authors does not necessarily represent the view point of editors and Indus Institute of Higher Education (IIHE) as well as authors' institutes

*Asif Mansoor is Research Fellow, University of, Karachi: Pakistan.
E.mail:asifmansure@yahoo.com
** Safia Mirza is lecturer, FUUAST, Karachi: Pakistan.

earlier the river is primarily a seasonal river and practically forms a drainage system for adjoining industries and localities.

SITE area is spread over 1800 ha consisting more than 2000 industries. About 60% are textile industries while the others are chemical, detergent, vegetable oils, beverages, food products, iron and steel etc. More than 10 million population of Karachi including major and small industries lying therein discharges about 244 MGD of untreated effluents through Lyari River into the sea (MP & ED Plan, 1999-2000). These effluents are the main cause for the pollution of south-eastern creeks. During northeast monsoon when current moves in anticlockwise direction, this contaminated polluted water also pollutes the main picnic spots at Manora, Sandpit, Hawks-bay and Paradise Point.

Sate of Waterways: Lyari River is a degraded system, characterised by Industrial wastewaters, plant or animal wastes, acids, alkalis, oils and other organic or inorganic chemicals, and some of these may be toxic synthetic detergents or radio active. The unauthorized residential colonies, commercial and industrial units, Cattle Dens, Dhobi Ghats, and Agricultural farms are constantly discharging their effluents in the river. These effluents, which are purely the mixture of raw sewage and untreated industrial effluents contaminate the marine environment and also effect the quality of salt along one channel of the Layri delta. The observations indicate, poor Industrial waste, private and public industrial waste disposal practices and the lack of private and public industrial waste treatment facilities, which results in the direct discharge of industrial waste into main stream of the river.

Review of literature shows that some of the studies are already conducted related to this topic. Like: in Pakistan for example, BALAFOURS (1991); EGC Report (1994); and Saeed; and at international level like: Clarence (1984); Zakrzewski; Misra; Central (1976), and Neill (1991).

Nobody has attempted a study about behaviour of waste water contributed the lyari river to main sea.

The main objective of the study is to find out the waste water effluents and its impact on the sea water and food.

This study specially examines the: (i), sate of waterways, (ii), Quantification of physical, chemical and metallic parameters, for effluents contributed by the river to sea with suggested models, which help the planner for better management of the river.

2. DATA AND METHODOLOGY

The strength of the pollutants are measured at the spot by using AQUASOLE test kits and samples are also collected for measuring physical and chemical parameter in the laboratory under standard methods for examination of water and wastewater (APHA 1989). The Fortran 90, SPSS have been used for the further calculations and analysis. Linear and non-linear regression (CWPU 1976) is used to determine the best-fit parameters for a model. For that we first obtained initial estimates for all of the variables being fitted for in the model by examining the curve generated by the data points. Then by using the initial estimates, computed the merit function and adjusted the variables in order to improve the fit of the model to the data points.

3. QUANTIFICATION OF PARAMETERS

***3.1 Physical parameters*: ** We observed that wastewaters vary in their characteristics; table1 gives an indication of physical characteristics ratios in the way to Lyari River from up to downstream.

Table 1

Physical Parameters	MFB-1	MFB-2	MFB-3	MFB-4	MFB-5	MFB-6	MFB-7	MFB-8	MFB-9	MFB-10	MFB-11
TSS (ml/l)	0.49	0.85	0.60	0.52	1.00	0.51	0.80	0.62	0.83	0.70	0.70
SS (mg/l)	0.19	0.30	0.15	0.06	0.93	0.74	0.51	0.45	1.00	0.59	0.56
TS(mg/l)	1.00	0.77	0.75	0.76	0.81	0.81	0.85	0.79	0.84	0.89	0.87
TDS(mg/l)	1.00	0.68	0.70	0.74	0.71	0.79	0.79	0.76	0.78	0.85	0.84
TVS (mg/l)	0.71	0.47	1.00	0.83	0.83	0.49	0.86	0.65	0.78	0.56	0.40

The waste enters to the sea follow the nonlinear equation

$$MFB\text{-}11 = a*TSS + b*SS + c*TS + d*TDS + e*TVS + f$$

having under line statistics,
Residual tolerance = 0.0000000001
Sum of Residuals = -9.37916411203332E-13
Average Residual = -8.5265128291212E-14
Standard Error of the Estimate = 42.0126364492327
Coefficient of Multiple Determination (R^2) = 0.7058444994
Proportion of Variance Explained = 70.58444994%
Adjusted coefficient of multiple determination (Ra^2) = 0.4116889
Durbin-Watson statistic = 2.27608768057225
and having regression variable result given in table 2.

Table 2

Variable	Value	Standard Error	t-ratio	Prob(t)
a	1.98	1.31	1.51	0.19
b	21.36	9.66	2.21	0.07
c	-2.11	1.24	-1.70	0.14
d	2.06	1.23	1.67	0.15
e	0.14	0.10	1.44	0.20
f	86.82	200.55	0.432	0.68

The lower and upper limit values for 95%, 99% confidence intervals are given in table 3 & 4 respectively.

Table 3

Variable	Value	95% (+/-)	Lower Limit	Upper Limit
a	1.98	3.367	-1.38	5.35
b	21.36	24.83	-3.46	46.20
c	-2.11	3.19	-5.31	1.07
d	2.06	3.17	-1.10	5.24
e	0.14	0.26	-0.11	0.41
f	86.82	515.53	-428.70	602.36

Table 4

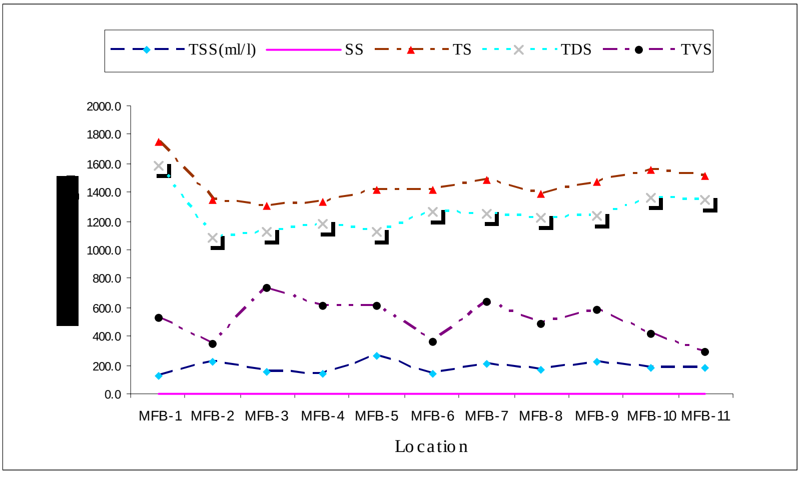
Variable	Value	99% (+/-)	Lower Limit	Upper Limit
a	1.98	5.28	-3.29	7.26
b	21.36	38.95	-17.58	60.31
c	-2.11	5.01	-7.12	2.89
d	2.06	4.97	-2.90	7.04
e	0.14	0.41	-0.26	0.56
f	86.82	808.64	-721.81	895.47

Our calculations regarding physical parametric indicate the following:-

- Variation in the ratios of TSS, TS, and TDS shows that the river enters into Metropolitan area of Karachi. It also indicates that effluents discharged by the industries contain soluble solids. Variation in TDS is proportional to its downstream flow.
- TVS variation shows the strength of wastewater with respect to its location.

The figure 1 shows the variation of physical parameters carried by the river.

Figure 1



3.2 Chemical Parameters

Chemical characteristics tend to be more specific in nature than some of the physical parameters and are more immediately useful in assessing the properties of wastewater. Table 5 below shows average chemical parameters at different location on the Lyari River contributed to the sea.

Table 5

Location	Bicarbonate (mg/l)	Chloride (mg/l)	Sulphate (mg/l)	Phosphate (mg/l)	Ammonia (mg/l)	COD (mg/l)	BOD (mg/l)	Detergent (mg/l)
	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8
MFB-1	290.00	417.00	357.00	2.07	10.16	556.75	240.25	4.56
MFB-2	212.75	302.50	158.50	1.58	10.03	578.75	248.25	5.42
MFB-3	260.00	283.75	187.25	1.63	10.16	500.25	221.50	2.00
MFB-4	315.00	299.75	155.50	1.44	10.18	625.75	262.50	3.02
MFB-5	287.50	262.00	177.25	2.34	10.25	576.50	238.50	5.08
MFB-6	331.50	292.50	201.00	2.67	9.69	697.00	385.25	5.77
MFB-7	352.50	283.50	178.75	2.57	10.20	701.00	279.25	7.11
MFB-8	312.50	291.75	202.75	3.06	9.33	805.00	275.00	3.49
MFB-9	307.50	313.75	187.50	4.14	9.73	648.00	223.75	3.81
MFB-10	375.00	339.50	174.50	3.72	9.70	503.00	178.00	4.13
MFB-11	325.00	376.25	142.25	3.59	9.65	534.00	196.25	3.00

The mass equation developed to simulate water quality behaviour which enters to sea is

$$\text{MFB-11} = e^{(a x_1 + b x_2 + c x_3 + d x_4 + e x_5 + f x_6 + g x_7 + h x_8 + i)}$$

with following statistical analysis

Nonlinear iteration limit = 250
Residual tolerance = 0.0000000001
Sum of Residuals = 1.32493239551235
Average Residual = 0.120448399592032
Standard Error of the Estimate = 5.39681916722841
Coefficient of Multiple Determination (R^2) = 0.998058431
Proportion of Variance Explained = 99.8058431%
Adjusted coefficient of multiple determination (Ra^2) = 0.9902921551
Durbin-Watson statistic = 2.044976837473385
Regression variable results are given in table 6.

Table 6

Variable	Value	Standard Error	t-ratio	Prob (t)
a	0.0049	7.032E-04	7.022	0.01968
b	-4.999E-03	9.284E-04	-5.384	0.0328
c	-4.488E-03	1.036E-03	-4.328	0.04944
d	0.550	3.098E-02	17.752	0.00316
e	1.044	0.115	9.007	0.0121
f	2.311E-03	2.794E-04	8.272	0.0143
g	7.026E-04	5.453E-04	1.288	0.3265
h	-0.098	2.2394E-02	-4.404	0.04788
i	-7.517	1.514	-4.964	0.03826

With following ninety, ninety five and ninety-nine percent, confidence interval under table 7, 8 and 9 respectively.

Table 7

Variable	Value	90% (+/-)	Lower Limit	Upper Limit
a	0.0049	2.053E-03	2.885E-03	6.99 E-03
b	-4.999E-03	2.711E-03	-7.710E-03	-2.28E-3
c	-4.4888E-03	3.027E-03	-7.516E-03	-1.46E-03
d	0.55	9.048E-02	0.4596	0.64
e	1.044	0.338	0.705	1.383
f	2.311E-03	8.159E-04	1.495E-03	3.127E-03
g	7.026E-04	1.592E-03	-8.896E-04	2.294E-03
h	-0.098	6.538E-02	-0.164	-3.323E-02
i	-7.517	4.42	-11.93	-3.096

Table.8

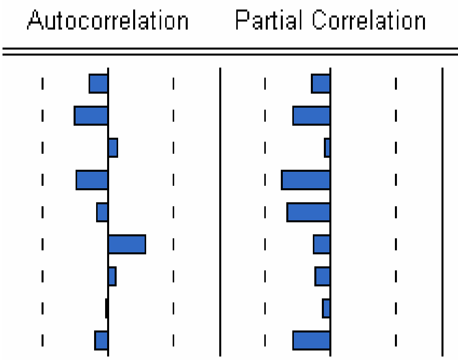
Variable	Value	95% (+/-)	Lower Limit	Upper Limit
a	0.0049	3.025E-03	1.912E-03	7.964E-03
b	-4.999E-03	3.994E-03	-8.994E-03	-1.004E-03
c	-4.488E-03	4.461E-03	-8.95E-03	-2.711E-05
d	0.55	0.133	0.416	0.683
e	1.044	0.499	0.545	1.543
f	2.311E-03	1.202E-03	1.109E-03	3.513E-03
g	7.026E-04	2.346E-03	-1.643E-03	3.048E-03
h	-0.098	9.634E-02	-0.194	-2.277E-03
i	-7.5176	6.514	-14.031	-1.002

TABLE 9

Variable	Value	99% (+/-)	Lower Limit	Upper Limit
a	0.0049	6.97E-03	-2.04E-03	1.191E-02
b	-4.99E-03	9.21E-03	-1.42E-02	4.215 E-03
c	-4.488E-03	1.02E-02	-1.47E-02	5.802 E-03
d	0.55	0.30	0.242	0.857
e	1.044	1.15	-0.106	2.195
f	2.311E-03	2.77E-03	-4.616E-04	5.084 E-03
g	7.026E-04	5.41E-03	-4.709E-03	6.114E-03
h	-0.098	0.22	-0.320	0.123
i	-7.517	15.02	-22.544	7.509

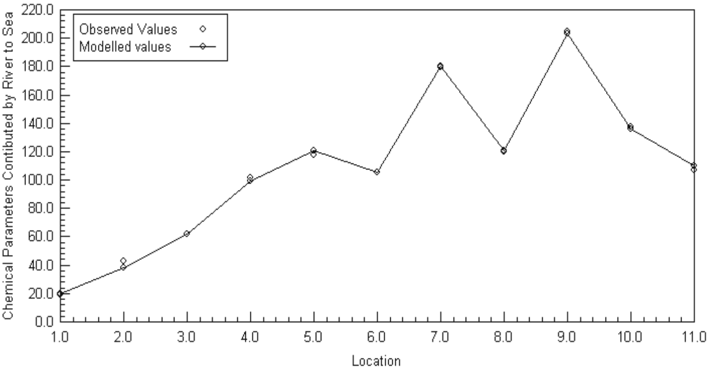
Table 10 below shows the Correlogram

TABLE 10



	AC	PAC	Q-Stat	Prob
1	-0.176	-0.176	0.4412	0.507
2	-0.305	-0.346	1.9159	0.384
3	0.089	-0.051	2.0579	0.560
4	-0.293	-0.457	3.8122	0.432
5	-0.104	-0.402	4.0719	0.539
6	0.340	-0.162	7.3706	0.288
7	0.062	-0.134	7.5059	0.378
8	-0.016	-0.073	7.5177	0.482
9	-0.116	-0.341	8.4724	0.487

The graph under figure 2 shows the relation between observed and modelled



values

The chemical parameters indicate :

- The presence of high ratio of chloride and sulphate creates smell in the channel.
- The high ratio of ammonia is due to the cattle forming and laundry activities. The presence of ammonia in water is toxic for marine life.
- The COD ratio is maximum which shows the presence of high load of industrial waste.
- Maximum BOD ratios means that there is high discharge of municipal and industrial waste.
- The detergent level ratio is high as compared to other location where laundry activity is present.

3.3- Metallic Parameters: Many heavy metals are toxic and can be taken up from the soil by plant. In contrast to most organic pollutants, metals do not decompose in nature and they remain in environment until they are physically removed.

The main contributors of these pollutants are industrial plant, engineering works. Arsenic (As), Magnesium (Mg), Manganese (Mn), Nickel (Ni), Lead (Pb) and Zinc (Zn) metals are present in the river main stream. Their average vales are given in the table below

Table 11

Location	As	Mg	Mn	Cr	Cu	Pb	Ni	Zn
	m_1	m_2	m_3	m_4	m_5	m_6	m_7	m_8
MFB-1	0.033	68.700	0.553	0.415	0.125	0.138	0.425	0.448
MFB-2	0.044	61.675	0.530	0.833	0.200	0.143	0.328	0.218
MFB-3	0.039	64.700	0.513	0.348	0.335	0.225	1.145	0.315
MFB-4	0.069	67.473	0.478	0.415	0.160	0.068	1.085	0.328
MFB-5	0.252	67.150	0.590	0.415	0.533	0.050	1.338	0.630
MFB-6	0.043	67.850	0.385	BDL	0.175	0.240	0.388	0.465
MFB-7	0.041	72.875	0.405	BDL	0.200	0.130	0.430	0.590
MFB-8	0.031	70.250	0.395	BDL	0.228	0.170	0.440	0.660
MFB-9	0.063	68.950	0.408	0.748	0.213	0.105	0.275	0.565
MFB-10	0.078	69.850	0.448	0.500	0.205	0.200	0.260	0.610
MFB-11	0.027	69.000	0.395	BDL	0.185	0.285	0.198	0.490

These contributed metallic parameters follow the equation
MFB-11 = $a\ m_1 + b\ m_2 + c\ m_3 + d\ m_4 + e\ m_5 + f\ m_6 + g\ m_7 + h\ m_8 + i$
with characteristics given below
Nonlinear iteration limit = 250
Diverging nonlinear iteration limit =10
Residual tolerance = 0.0000000001
Sum of Residuals = -1.04094510788855E-12
Average Residual = -9.46313734444133E-14
Standard Error of the Estimate = 3.84143018626275
Coefficient of Multiple Determination (R^2) = 0.9990162993

Proportion of Variance Explained = 99.90162993%
Adjusted coefficient of multiple determination (Ra^2) = 0.9950814965

Durbin-Watson statistic = 1.78672439885823
Its regression variables values with their statistics are given under table 12

Table 12

Variable	Value	Standard Error	t-ratio	Prob(t)
a	188.59	50.08	3.77	0.06
b	19.93	1.42	14.00	0.01
c	-839.24	29.41	-28.54	0.00
d	111.36	7.78	14.32	0.00
e	442.63	35.93	12.32	0.01
f	-144.94	32.07	-4.52	0.05
G	-28.40	7.72	-3.68	0.07
H	-263.25	31.22	-8.43	0.01
I	-843.81	92.41	-9.13	0.01

Where as, 95% and 99% confidence interval values are under table 13 & 14 respectively.

Table 13

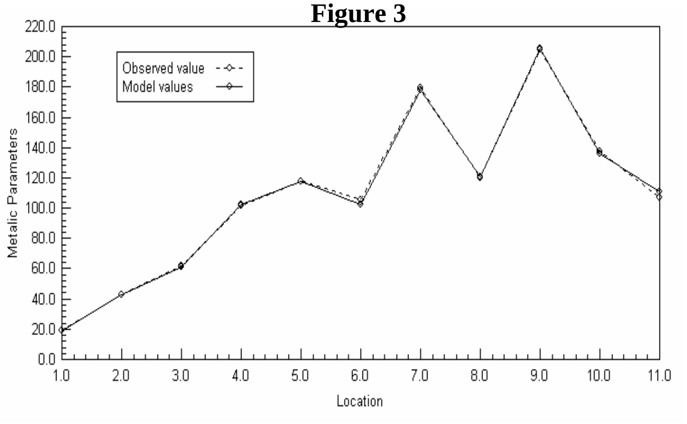
Variable	Value	95% (+/-)	Lower Limit	Upper Limit
a	188.59	215.48	-26.89	404.07
b	19.93	6.12	13.80	26.05
c	-839.24	126.54	-965.78	-712.70
d	111.36	33.46	77.89	144.82
e	442.63	154.59	288.03	597.22
f	-144.94	137.97	-282.90	-6.97
g	-28.40	33.23	-61.63	4.83
h	-263.25	134.32	-397.57	-128.93
i	-843.81	397.60	-1241.40	-446.21

Table 14

Variable	Value	99% (+/-)	Lower Limit	Upper Limit
a	188.59	497.03	-308.44	685.62
b	19.93	14.13	5.80	34.05
c	-839.24	291.88	-1131.13	-547.36
d	111.36	77.19	34.17	188.54
e	442.63	356.59	86.04	799.21
f	-144.94	318.24	-463.18	173.30
g	-28.40	76.66	-105.06	48.26
h	-263.25	309.83	-573.08	46.58
i	-843.81	917.10	-1760.91	73.30

The observed and modelled value behaviour is given under graph below

Figure 3



The presence of metallic ratio in the Layri river shows that

- Arsenic ratio is maximum due to presence of municipal waste at the location.
- Magnesium (Mg) ratio is maximum at Sir Shah Suleman location and there is a little variation in the presence of Mg at other location. However high quantity of Mg present in the drinking water is the main cause of diarrhoea.
- Increase in the Manganese (Mn) ratio is due to industrial effluents.
- The high ratios of the Lead, Zinc, Nickel is due to effluents of the metal industries and engineering work.
- Lead has many toxic effects, including inhibition of red blood cell formation, kidney damage and damage to nervous system.

3. CONCLUSION

In Pakistan as in much of developing world environmental quality has deteriorated rapidly. The pollutant discussed above adversely impacts on environment. Bad quality of waterways is resulting in health threats and loss of aquatic ecosystem and biodiversity. These untreated effluents causes depletion of bottom fauna, degradation of water quality, contaminate the marine organism and bio-accumulation of heavy metals in the fishes. Moreover suspended solids in the water remains suspended close to the coast. Its some parts taken by marine organisms accumulate in sea food users through food chain. In developing or under developed countries the major health concern is related to quality of water and food which already exposed to number of environment related problem. Safe drinking water, adequate sanitation and unpolluted water bodies are essential ingredients for healthy and productive society. According to WHO about 40% of death in Pakistan is due to waterborne diseases. From the above discussion, we conclude that polluted Lyari River is significant source of pollution to marine and nearby environment as it is purely combination of municipal and industrial waste. In future we will make a flow model of waste carried by the river. It will help to launch polices for the protection of fragile ecosystem. It will also help for the management of municipal and industrial effluents which is necessary for providing neat & clean living and working environment.

REFERENCES

APHA (1989), “Standard methods for the examination of water and waste water,” *American Public health Association, Washington, D.C*

BALAFOURS Final Report (1991), “Feasibility Study for Preparation of Sewage & Sewage Disposal Projects in Karachi”, *Balafours, Vol-II. Kraachi: Pakistan*

Clarence J.Velz. (1984), “Applied Stream Sanitation,” *John Wiley & Sons New York Brisbane Toronto Singapore.*

Central Water Planning Unit (1976), “Analysis of Trends in Public Water Supply.”

EGC Report (1994), “Environmental Technology & InfraStructure,” *M/s Engineering General Consultant (PVT) Ltd Lahore: Pakistan*

Haq, Ehsan Ul. (1971) “Landform Drainage System Basin in Karachi Region” *MP& ED Report, KDA MP-Rp-9 dated 31/3/71, Karach: Pakistan*

Misra S G, Mani D. *“Metallic Pollution”* Ashish Publishing House, New Dehli: India.

MP & ED Plan (1999-2000), “Karachi Coastal Recreation Development Plan,” *Karachi Development Authority, Pakistan*

Neill, Peter O,’(1993) , “*Environmental Chemistry*,” *Chapman & Hall, London*.

Saeed, R M. “Environmental Problems of Industrial Wastes in Pakistan,” *Public Health Engineering Circle, Lahore: Pakistan*

Zakrzewski, Sigmund F. “Principles of Environmental Toxicology,” *State university of New York at Buffalo, ACS, Washington, DC: USA*

APPENDIX
Nomenclature

Main Flow	
MFB-1	Rashid Minhas Road Bridge
MFB-2	Sir Shah Suleman Road Bridge
MFB-3	Nishtar Road Bridge
MFB-4	LiaquatAbad Road Bridge
MFB-5	Nawab Siddiq Ali Khan Road Bridge
MFB-6	Manghopir Road Bridge
MFB-7	Mewa Shah Road Bridge
MFB-8	Shershah Road Bridge
MFB-9	Mira Naka Causeway
MFB-10	Mauripur Road Bridge
MFB-11	End Of Lyari River
Physical Parameters	
TSS	Total Suspended Solid
SS	Settle able solids
TS	Total Solids
TDS	Total Dissolved Solids
TVS	Total Volatile Solids
Chemical Parmeters	
COD	Chemical Oxygen Demand
BOD	Biological Oxygen Demand
Metallic Parameters	
As	Arsenic
Mg	Magnesium
Mn	Manganese
Cr	Chromium
Cu	Cupper
Pb	Lead
Ni	Nickel
Zn	Zinc